

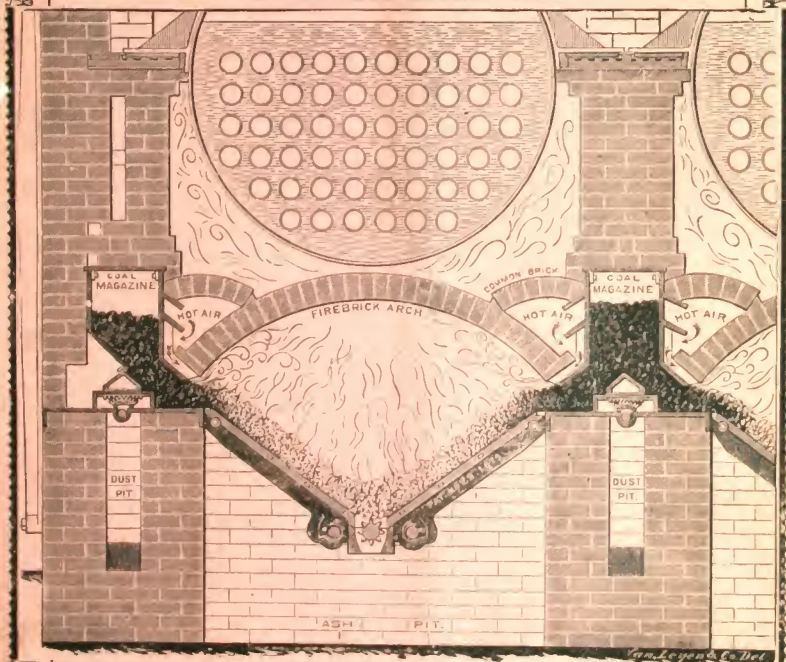
Murphy's Patent Smokeless Furnaces



MURPHY IRON WORKS

—) MANUFACTURERS OF (—

Smokeless Furnaces and Grates,
PATENT FEED WATER HEATERS, FUEL ECONOMIZERS, LIME
AND MINERAL EXTRACTORS.



Sectional View of Murphy's Patent Smokeless Furnaces.

Compound, Marine and Stationary Engines

CONDENSING AND NON-CONDENSING.

OFFICE AND WORKS :

Nos. 196, 198 and 200 Congress Street West,

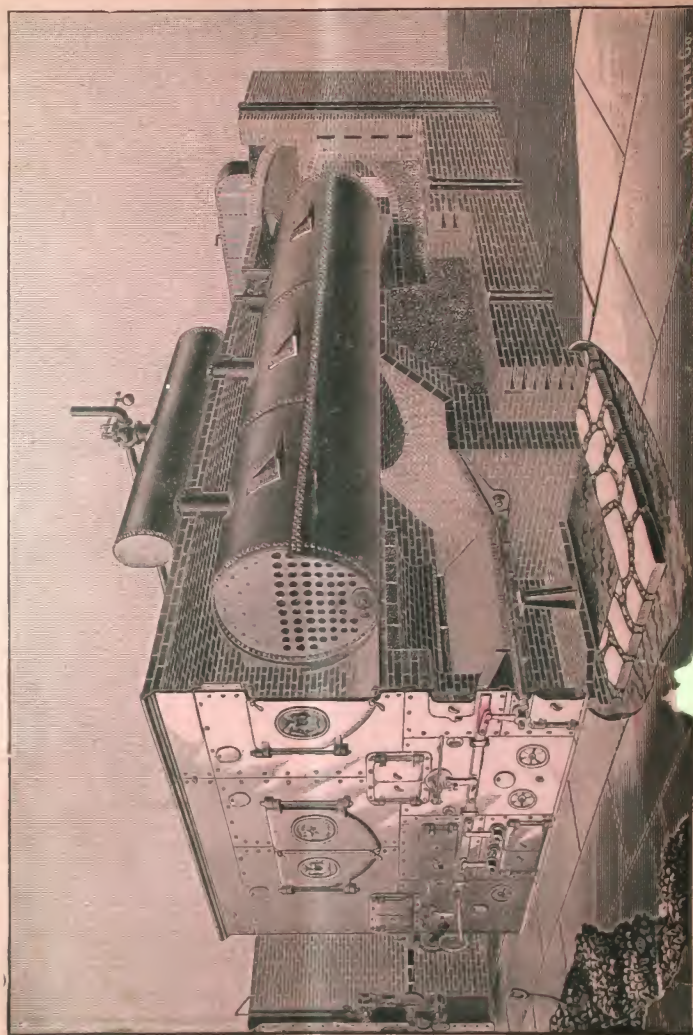
CORNER OF THIRD STREET,

DETROIT,

MICHIGAN.

John F. Eby & Co., Printers, 65 Congress Street West.

The Murphy Patent Smokeless Furnace



Is guaranteed to be a perfect Smoke Preventer, and to give a large economy over any Furnace now in use. Especially adapted for Slack Coal.

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CCA





WHAT MAKES A SMOKELESS FURNACE.

JAMES H. M'CABE,

NO. 772 CENT. BLAV.

CINCINNATI,



IT is not our intention to show you that smoke from coals can be burned, but we do intend to show how coals may be burned without smoke, and this distinction involves the main question of economy of fuel.

C. Y. Williams says: "Where smoke is once produced in a furnace or flue it is as impossible to burn it, or convert it to heating purposes, as it would be to convert the smoke issuing from the flame of a candle to the purposes of heat and light. When we see smoke issuing from the flame of an ill-adjusted common lamp, we also find the flame itself dull and murky and the heat and light less in quantity. Do we then attempt to burn that smoke? No, it would be impossible. Again, when we see a well adjusted Argand lamp burn without smoke, we also see the flame white and clear and the heat and light greater. In this case do we say the lamp burns the smoke? No, we say it burns without smoke. This is a fact, and it remains to be shown why the same language may not be applied to the combustion of the same coal and the same gas in the furnace as in the lamp."

Hydrogen is the main element in the gas evolved, and by the combustion of which flame is produced. It is well known that this combustion can only take place when mixed with certain quantities of air. It has also been fairly

shown that the air cannot be applied in volume, as, for example, immediately on opening the door of the common furnace for stoking the fires, you will see a long flame extending under the boiler. This is occasioned by the large volume of air which immediately passes through the open door. Combustion only takes place on the outer surface of this bulk of air, and continues to do so under the boiler until arriving at a point where the gases are not hot enough to ignite. Then flame ceases. This point of ignition rapidly recedes toward the open door, and very soon scarcely any flame is seen. The cold air is now sweeping up the chimney at a great rate, resulting in sudden contraction of the boiler and surroundings.

The above actually takes place every time you clean and feed the fires. What is the result? The temperature of your furnace is very low, and while in this condition you throw on a fresh supply of coal, close up the door and expect it to make steam. What folly! Again, the solid or carbonaceous part of your fresh charge is absorbing the heat from the incandescent fuel underneath, and at the same time the bituminous or hydrogen is separated from the solid. This is extremely light. The little air that gets through the fresh charge is not hot enough to ignite, both pass off with such buoyancy as to carry with them small particles of the carbonaceous or solid part of the coal, and this makes up the dense black smoke emitted from the chimney. The particles of carbon fall in the shape of soot, and the hydrogen and air mix with the elements. This process goes on until the greater part of the bitumen of the coal has been evolved. This is a valuable part of the fuel, and it has passed up the chimney unconsumed. If by this time the carbon, or what is left, coke, can get its supply of air, combustion will take place in the furnace and make carbonic acid gas, with a short white flame, which is as it should be. In the meantime you have cooled off your furnace and then had to heat it up again, subjecting boiler and

everything connected with it to sudden expansion and contraction. And then again the smoke leaves its deposits in the flues, which make labor in cleaning and likewise very largely destroy the heating surface of the boiler. But you say this is very plain, and how can it be remedied? If you must use a common furnace instruct your fireman to throw in but a shovelful of coal at a time, scatter well over the fire, open and close the door as quickly as possible, and you can save to a certain extent the waste explained above. Yet it matters not how well the fireman attends to his duties or how many appliances may be added so long as the fires are stoked through the open door. The results shown above can never be entirely overcome, the chimney will smoke every time the fire is fed or cleaned.

It has been the effort of the best talent of the past century to surmount the above difficulties. Success has been achieved to a certain extent, for to-day the Argand lamp is in general use; but on a large scale for making steam it seems still to be a doubtful question.

Let us bear in mind that coal gas, whether generated in a retort or a furnace, is essentially the same. Again, strictly speaking, it is not inflammable, as by itself it can neither produce flame nor permit the continuance of flame in other bodies. A lighted taper introduced into a jar of coal gas, so far from lighting the gas, is itself instantly extinguished. Effective combustion for practical purposes is, in truth, a question more as regards the air than the gas; besides, we have no control over the gas, as to quantity, after having thrown the coal into the furnace, though we can exercise a control over that of the air in all the essentials to perfect combustion. It is this which has done so much for the perfection of the lamp, and may be made equally available for the furnace.

It seems to have been taken for granted in practice on a large scale that if air by any means be introduced to the fuel in the furnace, it will, as a matter of course, mix with

the gas or other combustible in a proper manner and assume the state suitable for combustion, whatever be the nature or state of such fuel. This is a very great mistake.

In a laboratory the operation is slow, with no disturbing influence and unaffected by current or draught, but compare this with what takes place in a furnace. First, the quantity is large; secondly, the bodies to be consumed are partly gaseous and partly solid; thirdly, the gases evolved from the coal are part combustible and part incombustible; fourthly, they are forced into connection with a large and often overwhelming quantity of the products of combustion, chiefly carbonic acid; fifthly, the very air introduced is itself deteriorated in passing through the grates and incandescent fuel on them, and thus deprived of much of its oxygen; sixthly, and above all, instead of being allowed a suitable time, the whole are hurried away by the current or draught in large masses.

It will not do to admit the air through large openings, as it is then only superficially burned, as in a common candle, the flame being a thin film of white, hot vapor, enclosing an interior portion which cannot burn for want of oxygen. In the case of the furnace the large bulk of air cannot burn for lack of proper mixture with the gases, so both pass off largely unconsumed.

Now it seems obvious that on the control of the supply of air depends all that human skill can do in effecting perfect combustion and economy, *and until the supply of fuel and the quantity on the bars be regulated, it will be impossible to control the admission of air.*

The grate bars must be so arranged as to be able to have an even supply on them at all times and well covered. Every engineer or fireman realizes this who attends to his duties well; sufficient air can not pass through the bars, hence it must be got from another source, through a large number of small openings, and the nearer these openings to the fresh fuel the better.

The fuel must be supplied uniformly and continuously, slow or fast, according to necessity. It must be done without opening the fire doors. The fires must also be cleaned without opening doors.

When you can get the above conditions in a furnace you need have no fear as to its smokelessness or economy—both are certainties.

There are a large number of "smoke consumers" in the market, and so long as firemen are careful to open and close doors quickly, and put on but little coal at a time, and use choice lump, very little smoke is made, but this can be done without any smoke appliance, conditions being the same, but when boilers are crowded to their utmost capacity, say in winter, so that the fireman cannot fire as above, then the so-called smoke consumers do not work at all, and become rather a hindrance than a help. Automatic adjustable feed for fast or slow combustion is the thing required, and is the only furnace that can be entirely smokeless and economical under all conditions.

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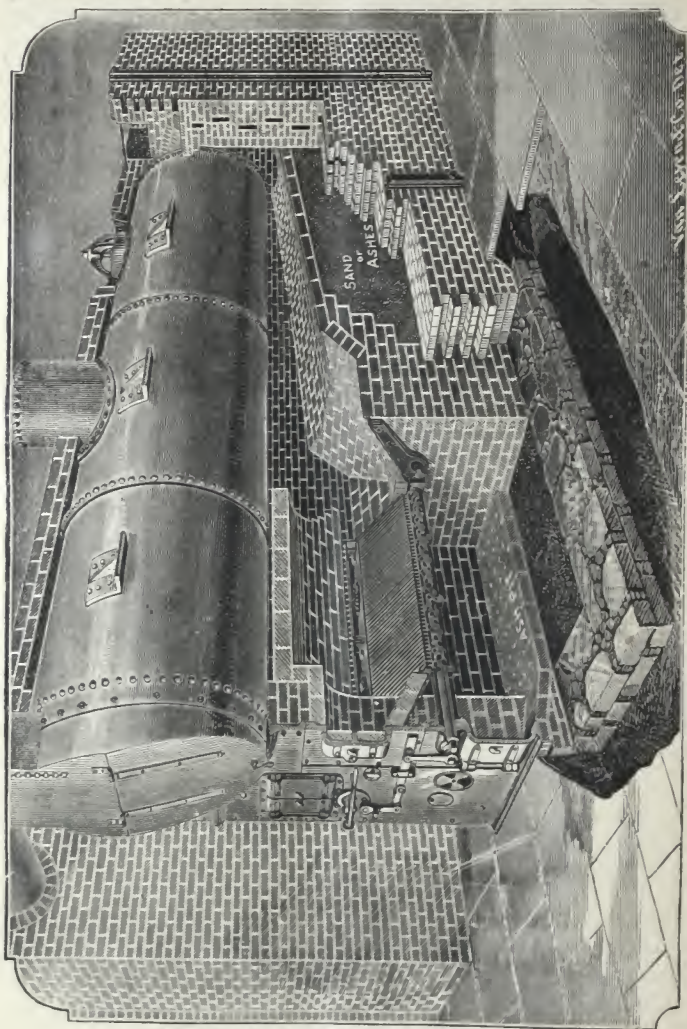
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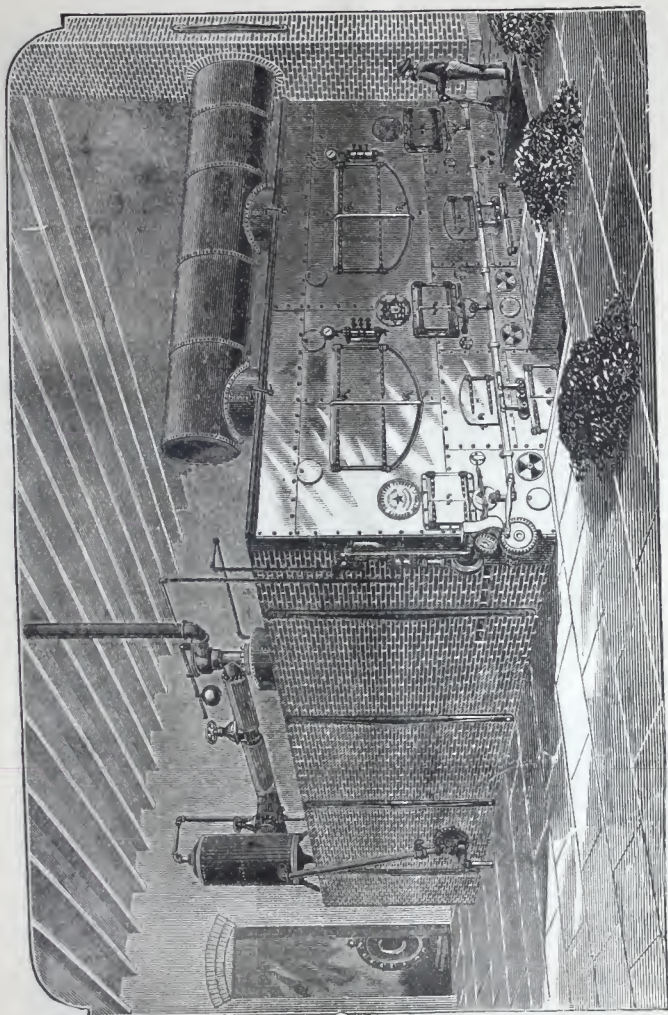
The Murphy Patent Smokeless Furnace

Is guaranteed to be a perfect Smoke Preventer, and to give a large economy over any furnace now in use. It is strong and durable. Condition of payments is based on the above guarantee. We do this because there are so many pretensions in the way of "Smoke Consumers," etc., in the market.



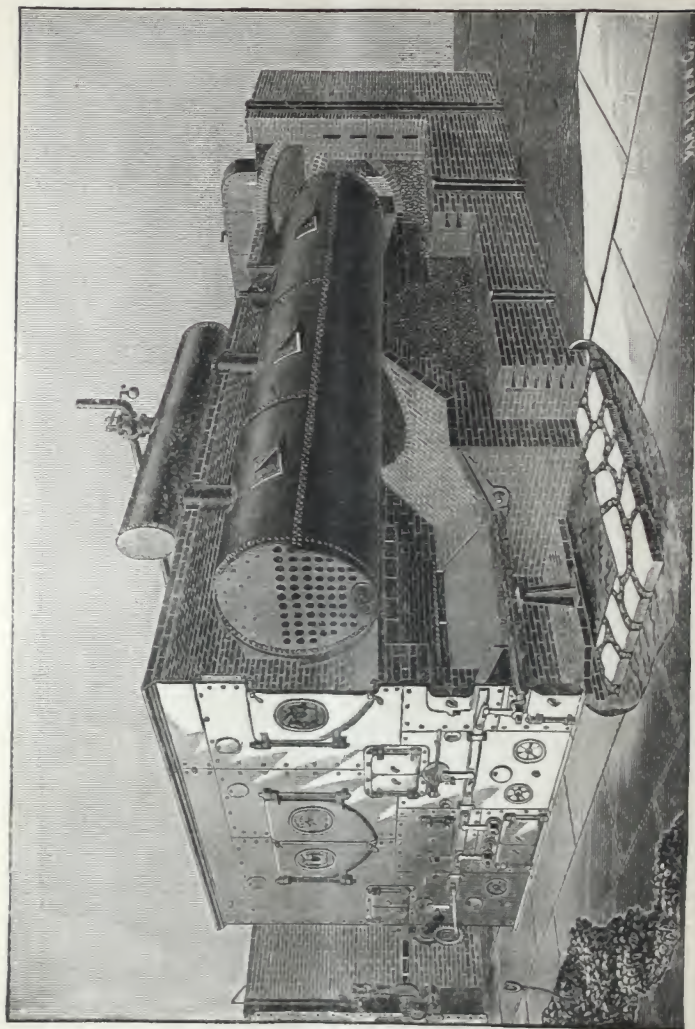
STYLE—HALF FRONT.

Murphy's Patent Smokeless Furnaces.



STYLE—FULL FRONT.

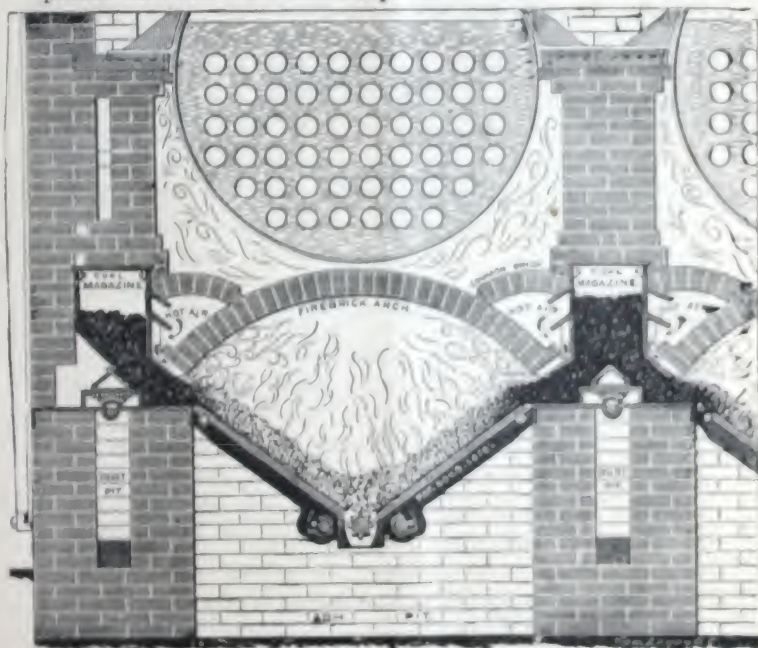
Murphy's Patent Smokeless Furnaces.



STYLE-FULL FRONT.

Murphy's Patent Smokeless Furnaces.

We take pleasure in introducing the "Murphy Smokeless Furnace," not a smoke-consumer, but a smoke-preventer, durable, economical, self-feeding, self-shaking grates; clinkers broken and removed without opening the door. Unlike any other furnace, the more it is crowded the more perfect combustion. It is the only furnace in the market to-day that meets the requirements of a perfect furnace for steam purposes. It is no experiment, having been in constant use for six years. Although there is a large amount of iron-work, it is so constructed as not to be exposed to the fires. As the grates are kept constantly in motion, the clinkers cannot form on them, hence air always passes between them and keeps them cool.



Sectional View of Murphy's Patent Smokeless Furnace.

The cuts represent front and sectional views. The furnace is especially adapted to the use of fine or slack coal, which is put into large hoppers or magazines. By referring to sectional cut you see at the bottom of magazine a casting resting on the brick work. This is a coking plate. The inclined grates rest against it at their upper ends. On this plate is placed an inverted open box, called the stoker box. It has a ratchet in each end; a shaft, worked from the outside, has a section of a pinion fitted to each ratchet, moving the stoker box back and forth on the coking plate every six, ten or fifteen minutes, as may be required. These stoker boxes push the coal on to the edge of the coking plate and grates; the coal then slides down toward the centre of the furnace by its own gravity. The triangular piece above the box moves out and in by a lever from the outside, which divides the coal and helps bring it down in front of the stoking boxes. Immediately over the coking plates and on the side of each magazine is the arch plate, on which the fire brick arch rests. Where the brick come in contact with the plate there are ribs about an inch apart on which the brick are placed. This leaves a small space between each rib. Air is admitted in front of the furnace, regulated by a damper; it passes up through a flue in the brick wall, then over the arch, and there takes up the heat from the brick work, passes down through the little openings and gives to the fresh fuel on the coking plate its supply of air; not only that but it is hot enough in itself to ignite any gases evolved, consequently immediate combustion takes place, and no smoke is made. By the time the coal reaches the grate the bituminous part is consumed, and what remains is coke. This gets its needed supply of air through the grates.

Less than a one-horse power engine is placed at the side; to this is attached a bar running across the front of the fur-

nace. This bar is connected by links to arms which move the stoking apparatus, shake the grate bars, and, if desirable, the clinker breaker can be connected in the same manner. The advantages of the Murphy Patent Smokeless Furnace are many, of which the following are a few :

It is smokeless.

It is economical.

It is durable, more so than a common furnace.

It takes less firemen in a battery of boilers.

It takes less attention than any other furnace.

No doors are opened to feed or clean the fires.

The boiler is subjected to a uniform temperature, thereby avoiding sudden expansion and contraction, which, in our judgment, is often the cause of boilers giving out prematurely.

It will evaporate more water with one pound of soft fine slack coal than any other furnace with one pound of lump from same mine or of same quality.

No soot is deposited in flues so as to destroy the heating surfaces.

The following results were obtained in a competitive test in the Cincinnati Industrial Exposition of 1879, conducted by John W. Hill, M. E.:

FURNACES	Murphy.	Walker.	Eureka.	Price.	Fisher.	Common.
Smoke.....	100	88	87	82	81	50
Economy, water per lb. coal.	12.45	7.00	8.74	11.80	4.82	7.00

These results show the Murphy to be ahead of all competitors, being perfectly smokeless and showing the remarkable economy in fuel of $77\frac{1}{2}$ per cent. over common furnaces. Five hundred dollars in gold was awarded in 1879.

I competed with five other furnaces in 1880, and was awarded the gold medal for superiority.

Summary of five evaporative tests made in Holly Steam Combination Co.'s boiler house, Lockport, N. Y.:

No. of test.....	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Date.....	Feb. 28, '80.	March 1.	March 2.	March 6.	March 8.
Boiler used.....	Murphy Furnace.	Murphy Furnace.	Murphy Furnace.	Common Grate.	Pierce Furnace.
Duration of test in hours.....	16½	12½	12	11	5½
Fuel used.....	Gas coal.	Soft slack.	Hard and soft slack.	Loyal Sock.	Naphtha.
Cost to evaporate one ton of water.....	32c.	25c.	24c.	38c.	64c.
Actual evaporation per lb. fuel	9.01	8.02	8.33	7.09	14.17

Basis, gas coal at \$2.85 per ton, soft coal slack at \$2.05 per ton, hard and soft coal slack mixed at \$2 per ton, Loyal Sock coal at \$2.60 per ton, naphtha (weight 7½ lbs. to gallon, or 220 lbs. per bbl.), at \$1 per bbl

Respectfully,

E. P. HOLLY,
Superintendent.

COMPARATIVE BOILER TEST

Made by WILLIAM H. SMITH, on JULY 25 and 26, 1884, at the WORKS OF THE BRUSH ELECTRIC CO., CLEVELAND, O., between a battery of two TUBULAR BOILERS (set separate) 66 in. diameter \times 18 feet long, with 54-inch tubes each, both boilers set with the MURPHY PATENT SMOKELESS FURNACE, and one TUBULAR BOILER, 70 in. diameter \times 18 ft. long, with 66-inch tubes set with COMMON FURNACE.

	Murphy Furnace.		Common Furnace.		Percentage of Economy.
	Two Boilers.				
1. Heating Surface.....	2582	sq. ft.	1545	sq. ft.	
2. Grate Surface.....	50	sq. ft.	23 ft. 4 in.		
3. Rate of Firing.....	50.6		66		
4. Kind of Fuel.....					
5. Duration of Test.....	7½	hours.	5¼	hours	
6. Average Steam Pressure.....	80.4	lbs.	76.8	lbs.	
7. Average Temperature of Feed.....	197.8	deg.	197.2	deg.	
8. Pounds of Coal burned.....	6385	lbs.	3672	lbs.	
9. Pounds of Refuse.....	636	lbs.	363	lbs.	
10. Pounds of Combustible.....	6389	lbs.	3612	lbs.	
11. Per cent. of Coal.....	9.11	per cent.	10.05	per cent.	
12. Coal burned per square foot Grate per hour.....	18.6	lbs.	30.9	lbs.	
13. Total Water Evaporated.....	55098	lbs.	23940	lbs.	
14. Water Evaporated per hour.....	7344.4	lbs.	4332	lbs.	
15. Water Evaporated per square foot Heating Surface per hour.....	3.07	lbs.	2.81	lbs.	
16. Water Evaporated per lb. Coal—Actual Conditions.....	8.58	lbs.	7.02	lbs.	
17. Water Evaporated per lb. Coal—from and at 212°.....	8.37	lbs.	6.87	lbs.	
18. Water Evaporated per lb. Combustible—Actual Conditions.....	9.387	lbs.	6.62	lbs.	
19. Water Evaporated per lb. Combustible—from and at 212°.....	9.837	lbs.	7.82	lbs.	
20. Pounds of Steam.....	Not tak'n		Not tak'n		
21. Horse-power.....	172.1	H. P.	108	H. P.	
22. Per cent. above Rated Capacity.....	298.3	H. P.	166	H. P.	
23. Temperature of Boiler Room.....	55.81	deg.	61.1	deg.	
24. Temperature of Flue Gases.....	384.6	deg.	76	deg.	
25. Force of Draught in inches of water.....	Not tak'n	inches.	440.8	deg.	
26. Force of Draught in inches of water.....	Not tak'n				

CLEVELAND, O., August 23, 1884.

The above test, or the comparative boiler tests made at our Works, July 25 and 26, was done under our supervision as well as Mr. Murphy's, and we know them to be correct and fairly obtained. The furnaces are smokeless, economical, and durable, and have done for us more than represented. The test speaks for itself as to economy.

(Signed),

N. S. POSSONS,

Supt. Brush Electric Co.

MURPHY IRON WORKS, Detroit, Mich.:

Genls.—The furnaces placed under our boilers in March last are giving us good satisfaction, and seem to successfully meet the requirements of the smoke ordinance, inasmuch that we have received no word of complaint since their starting. The percentage of economy is greater than we had anticipated, and we are confident, and thus far they have done as well and bid fair to prove lasting.

Yours very truly,

N. S. POSSONS, Supt.

CLEVELAND, O., Aug. 23, 1884.

Chicago, October 27, 1884.

Record of a series of tests made by THOMAS J. HOLMES, Chief Engineer, at James S. Kirk & Co.'s Soap Works (one of the largest Soap-making establishments in the world), for the purpose of ascertaining the value for steam-making of the various kinds of fuel named.

The furnace and boiler used was one of a battery of ten, set continuously, Murphy Smokeless Furnaces. The damper in stack remained wide open just as they use it every day. Capacity of chimney (175 feet high) is for twenty boilers, hence draft was very rapid. The steam from this boiler was used in connection with the other nine boilers for general purposes of soap boiling, etc., and did its proportion—and rather more of work than either one of the other boilers; the horse-power developed shows that it was crowded. The tests were made just after a heavy rain, and four of the coals were thoroughly saturated with surface water; two samples of each kind were dried by putting some on top of boilers, weighed accurately before and after, and found to contain per cent. of surface water as below; this was deducted, and hence the coal given represents dry coal. We are entitled to add to these units of heat enough required to heat or dry the coal in the furnace, but have not so done.

The boilers are 60" in diam. x 16 feet long x $\frac{3}{8}$ " thickness of shell, having 44 $\frac{1}{4}$ " tubes.

	Oct. 9th.	Oct. 10th.	Oct. 13th.	Oct. 14th.	Oct. 27th.	Square Feet. Square Feet.
Heating Surface	903	903	903	903	903	
Grate Surface, 4 feet long, 5 feet wide.	20	20	20	20	20	
Ratio of Heating to Grate Surface.	45.68	45.68	45.68	45.68	45.68	
Kind of Fuel used.	Wilmington Nut.	Wilmington Nut.	Mt. Olive Screenings.	Youghiogheny Screenings.	Pittsburgh Nut, 1st Pool.	
Duration of test.	8.45	8.30	8.30	8.30	8	Hours.
Average Steam Pressure	72.2	71.8	71.3	72.6	73.5	Pounds.
Average Temperature of Feed	133.5	137.3	135.2	137.1	135	Degrees.
Pounds of Coal burned, less the water	4043	3959	3691	3948	4000	Pounds.
Pounds of Refuse	932	812	751	403	408	Pounds.
Pounds of Combustible	3111	3147	3340	3155	3302	Pounds.
Per cent. of Ash.	23	20.5	18.79	16.02	15.2	Per Cent.
Coal burned per square ft. grate per hour.	23.1	23.38	21.33	21.3	25	Pounds.
Total Water Evaporated	26229	28541	28058	28672	34055.5	Pounds.
Water Evaporated per hour	3009	3337.7	2863	3177.2	4096.9	Pounds.
Water Evaporated per square foot heating surface per hour.	3.3	3.2	3.2	3.8	4.8	Pounds.
Water Evaporated per lb. of coal, actual conditions.	6.91	7.02	7.03	7.94	8.674	Pounds.
Water Evaporated per lb. of coal from and at 212°	6.91	7.5	7.36	8.32	9.081	Pounds.
Water Evaporated per lb. combustible, actual conditions.	8.46	9.11	8.62	9.18	9.659	Pounds.
Water Evaporated per lb. combustible, from and at 212°	8.85	9.13	9.02	9.61	10.112	Pounds.
Quality of Steam	not taken.	not taken.	not taken.	not taken.	not taken.	
Rated Horse Power	60	60	60	117.9	137	Horse Power.
H. P. developed from 319° temp. of feed, and 70 lbs. pressure.	102	113.8	108.7	157.9	128	Per Cent.
Per cent. capacity	70	73	89.1	85.6	415	Degrees.
Temperature of Flue Gases.	360.5	320.9	306.1	324	not taken.	Per Cent.
Percentage of Surface Water in Coal.	51.33	30	30	Dry.		
Cost of Coal per ton and cartage	\$1.15	\$1.50	\$1.70	\$2.15		

The above are no fancy tests, but heavy, honest work, in some cases nearly doubling the capacity of the boiler, and yet getting good evaporation for Illinois coal; also, good for Youghiogheny when the amount of refuse is considered. Many makers of grate bars, etc., will claim, perhaps, as great evaporation, but they cannot show the same proportion of work and same results.

MURPHY'S PATENT FEED WATER HEATERS.

The great majority of steam users lose sight of the fact that one-sixth of the escape steam made by their engines is sufficient to heat up the feed water to the boiler to a temperature of 208 to 212°, and either purchase a large and cumbersome heater or else dispense entirely with that eminently useful device, and in many cases send their feed water into the boiler cold.

When the water at a low temperature is introduced directly into the boiler it has a weakening tendency, inasmuch as the cold water, by reason of its gravity, descends to the bottom of the boiler, and that being necessarily the hottest part produces contractions unfavorable to the strength of the iron, and ultimately is the cause of so far weakening the boiler as to render it unsafe for steam-making purposes.

Experienced mechanics and engineers do not resort to the foregoing practices, but steam is being so universally used, and by many parties who have had no opportunity to learn all the desirable, and, in fact, highly necessary features beside the boiler and engine, and in some cases, on account of the necessities of the location, the heater, and also the lime and mineral extractor, is entirely lost sight of, and in many cases where these adjuncts are recommended, the price, and as is the case with the majority of heaters in the market, the space occupied is an undesirable consideration and feature, and therefore they are omitted.

We shall not dwell on the obvious and self-evident saving of fuel and wear of boiler, but desire to call the attention of those who do not possess a heater, or who are placing new engines, to the simple contrivance and effectual appa-

tus manufactured by the MURPHY IRON WORKS of DETROIT, MICH., and which has stood the test of eight years' constant use.

By reference to cut, the action of water and steam can be readily understood.

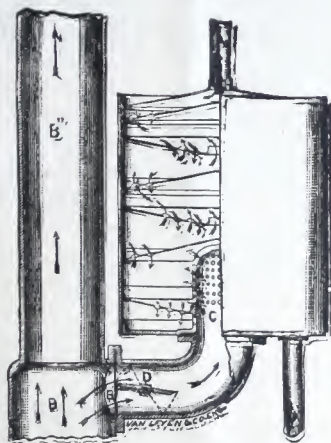
It takes only one-sixth of the exhaust steam.

It takes up very little space.

It can be attached very easily.

The interior is composed of alternate concave and convex copper flanges filled with very small holes, part of them being punched down and part upward to prevent any gurgling noise.

WARRANTED TO HEAT FEED WATER TO 210°.



The arrows indicate the descending water and ascending steam through the copper plates.

A is the cold water inlet.
A' is the hot water outlet.
B B' the main exhaust.

C the perforated exhaust nozzle.
D the valve for regulating temperature.

PRICE LIST.

No. 1.	9 in.	Diameter x 12 in.	Long,	1 to 15 Horse Power.....	\$50 00
" 2.	10	"	x 13	" 15 to 25 " "	60 00
" 3.	12	"	x 16	" 24 to 40 " "	70 00
" 4.	14	"	x 18	" 40 to 75 " "	80 00
" 5.	16	"	x 20	" 75 to 150 " "	90 00
" 6.	20	"	x 25	" 150 to 300 " "	125 00

The expense of attaching will be additional in all cases, and will be charged at cost. Men will be sent to put up heaters if desired, upon payment of board and traveling expenses, and the customary rate per day for their time; but any good mechanic can put up my heaters if directions are closely followed.

TESTIMONIALS.

The following letters speak for themselves of the value of our grate-bars and smokeless furnaces in some of the largest manufacturing establishments and buildings in this country:

MICHIGAN STOVE COMPANY, }
DETROIT, Mich., February 7, 1878. }

Mr. Thomas Murphy, 180 Bagg Street, City :

DEAR SIR—We take pleasure in responding to your request concerning your patent grates, which we have in use under our boiler at our works.

It is, as you are well aware, nearly two years since you put in these grates, and during this time they have given us entire satisfaction, and we have only had to replace six bars during all this time, and to-day the grates are in good condition. Our experience has been, since we concluded to allow you to put in these grates and use screenings in place of nut and lump size, that our fuel expense has been reduced fully one-third, and we could not ask for anything more satisfactory, and would not exchange said grates for any other we have ever used, and we had tested several of the leading grates in the market previous to having yours put in.

Yours,

G. H. BARBOUR,
Secretary Michigan Stove Co.

Since the above was given they have adopted our Smoke less Furnace with automatic feed.

DETROIT STOVE WORKS, }
DETROIT, March 22, 1878. }

Mr. Thomas Murphy, Detroit, Mich.:

DEAR SIR—In compliance with your request that we "say on paper" what we think of your patent grates, which we have been using for nearly one year I will state that so far there has been no perceptible wear upon them, that they are giving us entire satisfaction, and that we esteem them more highly than any grates we have ever before used, and we have used many kinds.

Since using your patent grates we have effected a saving of fully 35 per cent. in the cost of fuel, and we would heartily recommend them to all who are using coal for steam purposes.

Yours truly,

JAMES DWYER,
Superintendent.

THE TIDE-WATER PIPE COMPANY, LIMITED, }
WILLIAMSPORT, PA., May 27, 1884. }

Murphy Iron Works, Detroit Mich.:

GENTLEMEN—We have six of your furnaces in use at two of the pumping stations, of which three are at Muncy, Lycoming Co., Pa., and three at Shumans (Beaver Valley), Columbia Co., Pa., and they do excellent work. They are far superior to any furnace in use that I am acquainted with. At Muncy Station, for 26 days in April, 1884, our average evaporation was 9.44 pounds of water for one pound of anthracite pea coal. They must have intelligent management.

J. H. DICKSON,

Superintendent Main Line Tide-Water Pipe Co.

THE RUSSELL & MORGAN PRINTING COMPANY, }
CINCINNATI, April 16, 1884. }

Mr. Thomas Murphy:

DEAR SIR—We have had in use since June last two of your patent furnaces, and it gives us pleasure to inform you that in cleanliness and economy they give entire satisfaction.

It is the only furnace we have seen for the consumption of bituminous coal which is entirely smokeless; and if you could induce our neighbors to use them on their furnaces you would put us under lasting obligations.

Respectfully,

A. O. RUSSELL,

President and Treasurer.

CLEVELAND, O., August 23, 1884.

Mr. Thomas Murphy:

DEAR SIR—I am pleased to state that the furnace you put in our plant some nine months ago has been running constantly ever since, and has given perfect satisfaction. It has exceeded our expectations in the saving of fuel, and does away with the smoke completely. We have been to no expense in the way of repairs, and the furnace, from all appearances, is as good to-day as when put in.

We anticipate increasing our capacity, and in this event we shall certainly want more of your furnaces. (Signed) Yours truly,

THE CLEVELAND ELECTRIC LIGHT CO.,

Per F. J. STAFFORD, Sec'y and Manager.

THE BRUSH ELECTRIC LIGHT CO. OF BUFFALO, }
BUFFALO, August 30, 1884. }

Murphy Iron Works, Detroit, Mich.:

GENTLEMEN—Answering yours of 19th inst., which came in my absence. In July we burned an average of 385 lights nightly. We used 635,600 pounds soft coal slack, an average of 10½ tons per night. With an increase of 100 lights by your furnace we have decreased cost of coal over 60 per cent.

Yours truly,

WM. S. FREAR, *Secretary.*

JOHN V. LEWIS & CO., OILS, }
CINCINNATI, February 1, 1883. }

Murphy's Iron Works, Detroit, Mich.:

GENTLEMEN—We take pleasure in recommending your patent Smokeless Furnaces. When properly operated they are entirely smokeless, and a success.

We herewith give you an extract from our books, showing economy for two consecutive months—October and November, 1881. With the old style of setting under two boilers our fuel bills were \$706; for the corresponding months in 1882, with the Murphy furnace under same boilers, our fuel bills were \$481. We did somewhere from 10 to 15 per cent. more service in October and November, 1882, than in the corresponding months of 1881. The above shows a saving of \$225, without reckoning the greater duty performed.

We shall be pleased to answer any inquiry you may send, or show your patent furnaces in operation to any one desiring to see them.

Yours very truly,

JOHN V. LEWIS & CO.

MICHIGAN STOVE COMPANY, }
DETROIT, MICH., February 23, 1883. }

Mr. Thomas Murphy, City:

DEAR SIR—We beg to say that we have used your smoke consumer in connection with our boilers for the past three years, and have found it very satisfactory. It not only answers the object claimed for it, but it is a considerable saving of fuel.

We are so much pleased with its operation that we would not be without it for any reasonable consideration.

Yours truly,

MICHIGAN STOVE COMPANY.

They put in another furnace, January, 1886.

DETROIT, MICH., October 29, 1883.

Murphy Iron Works:

GENTLEMEN—We have been using the "Murphy Smokeless Furnace" since February 1, 1882. The arch has not been repaired since put in, and iron work is apparently just as good as the day it was put up. We have not spent \$5 on furnace for repairs since its completion. It is smokeless. Our boiler is in perfect condition. We use pea coal, at an average cost, per ten hours, of \$3.30; use on an average 75 horse power. It is the best furnace ever made, and pays for itself every year in the economy of fuel. We wish you success.

Yours respectfully,

PENINSULAR STOVE CO.

CINCINNATI, June 26, 1883.

To whom it may concern:

This certifies that we have now in use two Murphy Smokeless Furnaces, and find the same economical and smokeless, and we can freely recommend them to all who are in need of same.

Respectfully,

THE WINDISCH-MUHLHAUSER BREWING CO.

They now have six of our furnaces in use.

CLEVELAND, O., May 1, 1884.

To whom it may concern:

At the request of the agent of Mr. Thomas Murphy, I submit my opinion of the "Murphy Smokeless Furnace." I have had them in use under four boilers for nearly a year, and say unqualifiedly that they have given perfect satisfaction. They show no evidence of wear, and have cost nothing in the way of repairs. They have done away with the smoke far more completely than I thought possible. Under ordinary circumstances there is no smoke visible at the top of the stack. In regard to economy, I can't give exact figures, as no tests have been made, but judging from my coal bills for corresponding months, "The Murphy" makes a very large saving over my former settings.

I recommend both Mr. Murphy and his furnace unhesitatingly, as my dealings with both have been entirely satisfactory.

(Signed)

Respectfully,

J. B. PERKINS.

THE TIDE-WATER PIPE COMPANY, LIMITED,

TITUSVILLE, PA., January 8, 1883. }

Thomas Murphy, 200 Congress Street, Detroit, Mich. :

DEAR SIR—I delayed answering yours of December 27, as I expected before this to be able to give the results of some tests at Muncy, Pa., of evaporation obtained from coal burned, but those so far made have not been so conducted as to make me feel confidence in the statements. So far as they have progressed they indicate an evaporation of from 9 to 10 pounds of water for each pound of coal, the temperature of the feed-water being 130°. When we get a statement of results for several days I will report to you. At Shumans, where petroleum is burned, the feed-water temperature is about the same as at Muncy, and the evaporation averages above 18 pounds of water to 1 of oil, which I think pretty fair. Clark, in his book on combustion, names 18.13 pounds of water at 62° as the actual quantity which 1 pound of petroleum will evaporate.

Truly yours,

J. G. BENTON.

P. S.—Since the above was written they have made accurate tests, and have got even better results than the above. They used anthracite coal.

JAMES S. KIRK & CO.,
SOAP MAKERS AND PERFUMERS,
CHICAGO, October 18, 1884. }

To whom it may concern :

We have had two Murphy Furnaces in use about two years, and find they are smokeless and make a saving of twenty-five per cent. in fuel. We now have fourteen of the furnaces in use, they are working very satisfactorily.

JAMES S. KIRK & CO.

AMERICAN DISTRICT STEAM CO.,
LOCKPORT, N. Y., December 4, 1885. }

Murphy Iron Works :

Yours of October 12 was handed me a few days since, and I hasten to reply.

The first furnace set by you in January, 1878, is still in successful operation, and giving as good results as when first set. We had a few grate bars left, but have not been obliged to use one of them, and have them still on hand. The furnace has been run constantly eight months in the year, day and night, and the repairs have not cost to exceed \$10 in the eight years. The second furnace, set two years later, January, 1880, has been in constant use, and not a grate bar has been replaced, and the repairs will not amount to \$10. The two furnaces set September, 1885, are also in use, and even giving, I think, better results than the former two. With the four Murphy Furnaces we are doing more work than we could with the six ordinary furnaces that we formerly used. I cannot speak in terms high enough to suit myself; they are simply immense.

Yours respectfully,

AMERICAN DISTRICT STEAM CO.,
PER S. EVERETT, Superintendent.

CITY OF SAGINAW, MICH.,
CONTROLLER'S OFFICE, February 16, 1886. }

Murphy Iron Works, Detroit :

GENTLEMEN—Replying to yours of 9th inst., would say that your furnaces give us as good satisfaction as when first put in. We have not expended \$1 in repairing them, and they are apparently in as good condition as in the beginning.

Yours, etc.,

D. C. DIXON,

Controller.

OFFICE OF DENNIS LONG & Co.,
LOUISVILLE, KY., May 24, 1886. }

Murphy Iron Works, Detroit, Mich. :

GENTLEMEN—In reply to yours of 21st inst., would state that we have had two of your Murphy Furnaces in operation over a year, and are well pleased with them; in fact, we are so well satisfied, that we are now putting in two more.

Yours respectfully,

DENNIS LONG & CO.,

PER T.

CUYAHOGA COUNTY OFFICE, }
CLEVELAND, O., May 26, 1886. }

Murphy Iron Works, Detroit, Mich.:

After a trial of ten months of your "Murphy Smokeless Furnace" I find it superior to the claims made for it by your people, viz., as to its being smokeless, economical in fuel and durable. I can therefore most cheerfully recommend it to the world as a complete smokeless furnace. Wishing you success, I remain,

Yours truly,

HERMAN BENHOFF,
Engineer of County Building

THE CHILDREN'S HOME,
192 NINTH ST., BET. PLUM AND CENTRAL AVE., }
CINCINNATI, November 6, 1886. }

Murphy Iron Works:

GENTLEMEN—It gives us great pleasure to recommend your "Smokeless Furnace." We have used your furnace for four years, and consider it perfect in its working, and in the fullest sense accomplishing all you promised us from its use.

We are, with respect,

Very truly,

THE CHILDREN'S HOME,
PER MURRAY SHIPLEY, President.

INSTITUTION FOR THE DEAF AND DUMB,
FLINT, MICH., June 1, 1886. }

Murphy Iron Works, Detroit:

DEAR SIRS—You ask for my opinion of your furnaces. We have used them now less than a year, but for a sufficient length of time to demonstrate their great value. They are labor saving, as the fireman has little more to do than fill the magazines; economical, as out of the same amount of fuel more duty can be obtained; and cleanly, as, properly managed, they will consume their own smoke. Until one year ago, our buildings were heated by steam generated with wood, burned in a common furnace. Four boilers were taxed to their utmost in extreme winter weather, and then furnished insufficient heat. During the past winter no more than two boilers were ever required, and four-fifths of the time one has furnished all the steam, with the exhaust from the engine, that was required to heat our seven buildings and make them comfortable, and a saving of \$3,500 will be realized in our fuel account in that length of time. While this is due in part to a new heating apparatus and some other changes, I am sure your furnaces are entitled to their share of the saving shown. We appreciate them highly, and should be very reluctant so do without them.

M. T. GASS,

Superintendent.

MICHIGAN STATE PRISON, }
JACKSON, MICH., June 14, 1886. }

Murphy Iron Works, Detroit:

GENTLEMEN—Replying to yours of the 10th inst, I beg to say that we have had your "Murphy Patent Smokeless Furnace" in use here for several months, and that it is entirely satisfactory in every way. It performs in every way all that was claimed for it.

Very sincerely,

H. F. HATCH,

Warden.

OBERLIN COLLEGE CONSERVATORY OF MUSIC }
OBERLIN, O., June 14, 1886. }

Mr. Thomas A. Murphy, Detroit, Mich.:

MY DEAR SIR—I have been intending for some time to write you about the furnace which you placed in Warner Hall last fall. It was a great delight to us during the entire winter. Our janitor says he could start the steam gauge in five minutes at any time in the morning. It is always ready at a moment's notice for any amount of heat needed. The smoke is practically done away with. I think we saved last winter fully 40 per cent. in expense of warming the buildings over the year before.

Sincerely yours,

FENELON B. RICE,

Director.

CINCINNATI, O., July 16, 1886.

Mr. Thomas Murphy:

DEAR SIR—I am pleased to state that the four furnaces you put in our plant over a year ago have been running night and day since they were put in, and have given perfect satisfaction. They are the only furnaces I have ever seen that are smokeless. I will only be too well pleased to show any one you or your agent may send or bring to look at the furnaces.

W. H. BRESLER,

Engineer of the Burnett House.

LANSING, MICH., June 24, 1886.

Murphy Iron Works, Detroit, Mich.:

GENTLEMEN—I have seen your furnace in operation in Cleveland, Ohio, and have used it here in Lansing, Mich., for the last year myself, and from my knowledge of it I am pleased to say I think it a perfect success, not only in economy, but it does away with all of the nuisance of black smoke and dirt, which is a common occurrence with other furnaces. I remain,

Respectfully yours,

CHAS. D. DODGE,

Engineer Water Works.

NORTON MILLING CO.,
MADISON STREET BRIDGE, }
CHICAGO, June 28, 1886. }

To whom it may concern:

We have had the "Murphy Furnace" in operation about two years under two boilers 65" x 16'. After a very careful test, and after trying and discontinuing the use of three or four other furnaces, we have no hesitation in stating that for simplicity, durability, economy, and the perfect combustion of smoke, the "Murphy Furnace" is preferable to any we know of, and believe it to be the best furnace in use at present.

THE NORTON MILLING CO.,
EDMUND NORTON, Manager.

ROOT, STRONG & CO.,
134 AND 136 JEFFERSON AVENUE, }
DETROIT, MICH., July 26, 1886. }

Murphy Iron Works, City:

GENTLEMEN—We are pleased to say that the two "Murphy Patent Smokeless Furnaces" you put in for us in September, 1884, are all that you claimed for them, viz., they are perfectly smokeless, easily managed, and make a large saving in fuel. In regard to making any repairs, will say that it has only cost us only 60 cents, and that was for the small engine that runs the furnaces. We heartily recommend them to all steam users, and will be pleased to show their working to any and all that may call.

Respectfully yours,

N. WILLIAMS,
Engineer Root, Strong & Co.

REFERENCES.

The following are some of the largest firms using our furnaces in various parts of the country:

LOCKPORT, N. Y.

American District Steam Supply Co., 1st order, 1878; 2d order, 1880; 3d order, August, 1885.

Lockport Paper Co., November, 1884; 2d order, December, 1887.

Lockport Gas Light Co., 1st order, August, 1885; 2d order, March, 1886.

The Oliver Bros., June, 1887.

Holly Manufacturing Co., Oct., 1887.

BUFFALO, N. Y.

Brush Electric Light Co., 1st order, January, 1884; 2d order, December, 1885; 3d order, January, 1887.

Buffalo Express Publishing Co., September, 1885.

BROOKLYN, N. Y.

American Cotton Oil Co., 1st order, January, 1885; 2d order, June, 1885.

DETROIT, MICH.

Michigan Stove Co., 1st order, January, 1879; 2d order, January, 1886.

Peninsular Stove Co., February, 1882.

Union Mills Co., November, 1882.

Root, Strong & Co., September, 1884.

Russel Wheel & Foundry Co., March, 1886.

The Edison Illuminating Co., 1st order, October, 1886; 2d order, under Root boilers, May, 1887; 3d order, August 11, 1887.

The Michigan Bolt and Nut Co., June, 1887.

SAGINAW CITY, MICH.

Saginaw City Water Works, 1st order, April, 1883; 2d order, June, 1883.

FLINT, MICH.

Institution for the Deaf and Dumb, July, 1885.

LANSING, MICH.

Lansing Water Works, August, 1885.

JACKSON, MICH.

Michigan State Prison, August, 1885.

CINCINNATI, OHIO.

Children's Home, 1879.

Cincinnati Industrial Exposition, 1879.

J. V. Lewis & Co., 1st order, July, 1882; 2d order, October, 1882.

The Russell & Morgan Printing Co., May, 1883.

Strobridge Lithographing Co., September, 1883.

The Windisch-Muhlhauser Brewing Co., 1st order, March, 1883; 2d order, August, 1883; 3d order, October, 1883.

- Burnett House, August, 1885.
 The Jung Brewing Co., February, 1886.
 The J. Walker Brewing Co., 1st order, July, 1886; 2d order, June, 1887.
 Krippendorf, Dittman & Co., October, 1886.
 The Vine St. Cable R'y Co., June, 1887.
 Mt. Adams & Eden Park Inclined R'y Co., June, 1887.
 LOCKLAND, OHIO.
 The Stearns & Foster Co., June, 1886.
 CLEVELAND, OHIO.
 J. B. Perkins, 1st order, June, 1883; 2d order, August, 1883.
 E. M. McGillan & Co., September, 1883.
 Root & McBride Bros., November, 1883.
 Brush Electric Co., November, 1883.
 Cleveland Milling Co., February, 1884.
 Messrs. Jones & Hamilton, August, 1884.
 Cleveland Electric Light Co., 1st order, November, 1883; 2d order, March, 1885; 3d order, July, 1886; 4th order, October, 1886; 5th order, October, 1887.
 Cleveland Medical College, December, 1885.
 The Otis Iron & Steel Co., January, 1886.
 Cuyahoga Co. Court House, April, 1885.
 C. G. King, 1st order, October, 1883; 2d order, May, 1885; 3d order, September, 1887.
 J. H. Wade, Jr., October, 1886.
 J. F. Rust, October, 1886.
 The Hollenden, October, 1887.
 Cyclorama Building, November, 1887.
 AKRON, OHIO.
 The B. F. Goodrich Co., 1st order, July, 1885; 2d order, July, 1887.
 ST. LOUIS, MO.
 The Diamond Match Co., February, 1886.
 ST. JOSEPH, MO.
 Mokaska Manufacturing Co., February, 1886.
 Brittain, Richardson & Co., November, 1886, under Heine boilers.
 KANSAS CITY, MO.
 Ramsey, Millett & Hudson, 1st order, July, 1886; 2d order, July, 1887.
 The National Water Works Co., May, 1887.
 The Metropolitan Street (cable) R'y Co., June, 1887, under Babcock & Wilcox boilers.
 The Kansas City Cable R'y Co., June, 1887, under Firmenich boilers.
 Kansas City Chamber of Commerce, July, 1887.
 New England Building, December, 1887.
 LOUISVILLE, KY.
 Dennis Long & Co., 1st order, June, 1885; 2d order, May, 1886; 3d order, April, 1887; 4th order, September, 1887.

LA PORTE, IND.

King & Fields, 1st order, February, 1884; 2d order, September, 1884.

SHUMANS, PA.

Tide Water Pipe Line Station (using hard coal), June, 1882.

MUNCY, PA.

Tide Water Pipe Line Station (using hard coal), June, 1882.

CHICAGO, ILL.

James S. Kirk & Co., 1st order, June, 1883; 2d order (12 furnaces), April, 1884.

Norton Milling Co., January, 1885.

Phoenix Distilling Co., August, 1885.

Studebaker Bros. Mfg. Co., March, 1886, under Babcock & Wilcox boilers.

The Fortune Bros. Brewing Co., November, 1886.

The Palmer House Company, July, 1887.

Chicago Sugar Refining Co., November, 1887, under Babcock & Wilcox boilers.

OBERLIN, OHIO.

Oberlin College Conservatory of Music, 1st order, October, 1885; 2d order, November, 1887.

COLUMBUS, OHIO.

Columbus Buggy Co., 1st order, March, 1886; 2d order, October, 1887, under Babcock & Wilcox boilers.

The Columbus Edison Electric Light Co., 1st order, July, 1887, under Root boilers; 2d order, November, 1887.

COLUMBUS, IND.

Gaff, Gent & Thomas, April, 1886.

NEW ORLEANS, LA.

S. Hernshiem, Bro. & Co., June, 1887.

COLLINSVILLE, CONN.

The Collins Co., July, 1887

DUNKIRK, N Y

Brooks Locomotive Works, October 1887, under Moore water tube boilers.

GLOUCESTER, MASS

Russia Cement Co., December, 1887, under Moore water tube boilers.

